# The Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory.

FEBRUARY, 1889.

*Thou Lord in the beginning hast laid the foundation of the earth and the heavens are the works of thy hands.*

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# THE SIDEREAL MESSENGER,

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## THE EFFECTS OF ROTATION UPON THE FLUID ENVELOPE OF A REVOLVING SPHERE*.

SEVERINUS J. CORRIGAN.

For THE MESSENGER.

As stated on the first page of this paper, I think that we are warranted by the concordance of theory and observation, in regarding the oceanic circulation as, primarily, an effect of rotation, but this bare statement needs a qualification; rotation is not the only factor that operates to produce the phenomenon as we know it; the configuration of the coasts is also an essential element. I purpose to demonstrate that it is to the combined influence of both that the main currents of the ocean are principally due.

It is well known that the tangential component of the centrifugal force generated by the earth's rotation is a pressure exerted equatorward, and that it is this pressure that sustains the waters of the ocean, in the equatorial regions, above the level proper to them if the earth had no axial rotation. It was by the operation of this component force, when the matter of the earth was in a fluid state, that the excess of matter near the equator was produced and sustained. If this upholding force were to be destroyed at any point, or along any line, it is evident that any fluid matter, the waters of the ocean, for instance, would seek to return to the normal level at that point or along that line. This tendency is exemplified by the action of the tides. It is well known that the "tide wave" is, in the open ocean, simply an elevation of the waters to an apex, this elevation being due to the diminution of terrestrial gravity at a given point by the moon's gravitative force, and to the consequent lateral pressure exerted by the aqueous particles tending to flow toward the point where the force of gravity is de-

* Continued from Vol. VII, p. 429.

creased, this pressure sustaining the waters above the normal level. When, by the diurnal rotation of the earth, the solid matter of the latter, or the coasts, approaches the fixed elevation of waters, or the "tide wave," the latter is deprived of the support on one or more sides. It is true that the pressure is exerted upon the rigid land, as well as upon the movable waters, but the former cannot move up to the support of the "tide wave," which, therefore, is precipitated upon the shore, and rushes inward through the indentations of the coast, producing that well known phenomenon, the tide. In an analogous manner the waters of the oceans near the equator, elevated as they are by the pressure due to the tangential component of the centrifugal force, must flow toward the north and the south seeking their normal level, where the trend of the coast lines is such that the supporting pressure is removed.

The force of the tangential component cannot, of course, be annihilated; it must act upon the rigid land as well as upon the movable waters, but by the interposition of the former, a practical destruction of the force, so far as it operates to sustain the waters above the normal level, will be effected; there will be a strain upon the land but the latter cannot move up to the support of the elevated waters; the latter must therefore flow down along the coasts northward and southward, as it were "under the lee of the land." If the trend of the coast were east and west, and the tangential pressure or upholding force at a right angle to it, this pressure might be likened to that of a mighty wind blowing equatorward and forcing the waters in that direction or "off shore." Under the condition of equilibrium in the fluid matter of the earth the "tangential component" is exerted directly toward the equator from both sides of the latter, and is at a maximum in latitude 45°. If we now regard this fluid matter as not in a state of perfect equilibrium or, in other words, if we admit the tendency to eastward pressure due to the disturbance of equilibrium by neighboring bodies, and the existence of which I have endeavored to demonstrate on preceding pages, the resultant pressure must be, generally, southeastward in the northern hemisphere, and northeastward on the other side of the equator. If the earth were completely covered by water the result of

this pressure would be an excess of eastward motion in the aqueous particles near the equator, a condition which probably exists in the fluid envelope of the sun; but the rigid land is interposed amid the waters, preventing such action and giving rise to a motion of the aqueous particles in a direction differing from the above. I claim that the *modus operandi* is such as to produce the ocean currents as we know them.

To comprehend the matter clearly, the reader need only take a map showing the whole Atlantic basin, observe the trend of the coast lines on both sides thereof, and represent the forces brought into action by the rotation of the earth by arrows pointing southeastward in the northern hemisphere, and northeastward in the other; strictly speaking these arrows should point more directly east near the equator, for on that circle the tangential component is 0.

It will be seen that the forces so represented will tend to cause the waters of the Atlantic not only to be raised near the equator above the level which they would occupy if the earth had no rotation, but also to press toward, or to converge to a point or region on the west coast of Africa, about the Gulf of Guinea; the waters there will thus be elevated to an apex above the level in the same latitudes on the opposite or American coast. Let the reader now turn his attention to the coast lines of North and South America. He will see that the arrows representing the forces will be directed off these coasts, in fact the direction will be almost at a right angle to the trend of the North American coast, but somewhat less to that of South America, particularly in the more southern parts.

This pressure away from the coasts, which may be likened to a mighty wind blowing "off shore," must tend to leave, as it were, a valley or trough near the coasts, down which trough the piled-up waters near the equator will, by the action of gravity, flow toward the north and the south, passing, as it were, "under the lee of the land." The north-flowing waters will form the well known Gulf Stream, while the southerly flow constitutes the Brazil current.

This out draught from the equatorial waters along the western coasts must set up a westward flow along or parallel to the equator from the apex on the African coast.

This westward moving stream is the equatorial current which thus flows, as it were, down hill from the apex in the Gulf of Guinea to the points of outflow on the American coast or the starting point of the Gulf Stream and the Brazil current. It is worthy of note that the former current, whose course is northeast along the coast of the United States, has its northerly movement stayed and its course deflected sharply eastward in latitude 45°, in which latitude the "tangential component," pressing southward, is at a maximum, and also where the trend of the coast changes so as to allow the southerly pressure to be exerted in full force; in other words where the stream forces out from the protection of the land.

The southern flow, or the Brazil current, is also deflected eastward, but about latitude 35° south. The comparative inferiority of the latter current, both in strength and in length of course, is probably due, at least in part, to the fact that the trend of the South American coast is such that the portion of the upholding force rendered inoperative by the interposition of the land is not so great as in the case of the Gulf Stream, the latter flowing along a coast whose trend is, up to latitude 45° north, nearly at a right angle to the "off shore" pressure. As is well known both of these currents turn at first sharply to the east in about the latitudes named above.

The principal part of the Gulf Stream, crossing the Atlantic, becomes merged into the North African current, which flows along the African coast toward the equator, while the Brazil current swerves first eastward across the South Atlantic, and eventually joins what is called the South African current, which flows northward toward the equator along the African coast.

These currents may be regarded as representing respectively the southeastward and the northeastward pressures arrested by the African coast, and deflected equatorward to the region of the Gulf of Guinea, where the waters are piled up to an apex, as has been shown above. From this point or apex they again flow westward as the equatorial current and make the same circuit as that above described, the process being repeated unceasingly, or so long as the forces brought into play by rotation and gravity, and the present

trend of the coast lines exist. Similar action may be seen in the Pacific Ocean; the Japan current represents the Gulf Stream, and the Peruvian current northward along the west coast of South America is analogous to the South African current, while the flow southward along the west coast of North America may be regarded as the counterpart of the North African current. These principal streams naturally give rise to minor or derivative movements of the waters, but of these it is unnecessary to speak. The acceptance of this hypothesis does not necessitate the complete rejection of the generally received notion which regards prevailing winds and the differences of temperature in the waters of the oceans as causes of the phenomenon; these doubtless have a marked effect, but they only act as auxiliaries; the main or primary cause must be found, I think, in the action of the forces above mentioned. Unless well established laws of "mechanics," and, in particular, the law of "gravitation," be abrogated or suspended, the waters of the oceans must flow as they do, even were the atmosphere perfectly quiescent, and the temperature of the waters uniform. The fact that the currents follow the coast lines so closely is, I think, very significant, and corroborates the hypothesis which I have advanced.

I have thus endeavored to demonstrate that the four phenomena, viz.; sun spots and their perodicity, terrestrial storms, the seismic forces, and the oceanic circulation are primarily effects of rotation and gravitation. Of the absolute nature and cause of the force called "gravity" we have, at present, no knowledge; we know it only through its effects, but the determination of the probable proximate origin or cause of rotation is not a very difficult task.

On preceding pages I have shown the form and dimensions of the orbit in which a material particle on the equatorial circumference of the earth would move under the influence of the centripetal attractive force of the earth's mass and the linear velocity due to the axial rotation of our globe, that is, if said particle were free to move around the center of the earth and if the whole mass of the latter were concentrated at that point. The linear velocity of rotation has thus been regarded as a factor in the formation of the orbit, or as a cause, but I think that the axial rotation itself may be re-

garded as an effect due to an original orbital revolution of independent particles of cosmic matter. We may be aided in our search for the origin or cause of the axial rotation by a consideration of the much discussed but ever interesting "nebular hypothesis." We can conceive of the existence of a vast irregular mass of nebulous matter of indefinite extent moving through space, and of whose origin or destination it is not essential to our purpose that we should have any definite knowledge. As no valid physical objection stands in the way, we may regard it, if we will, as called into existence directly by the fiat of the omnipotent Creator, but whence it comes or whither it goes is immaterial in this connection. It suffices to assume this matter and motion to exist, and to the legitimacy of this assumption modern astronomical observations furnish abundant attestation. It is also most reasonable to assume that some portions of this irregular nebulous mass will be more dense than others; *i. e.*, that there will be a greater aggregation of matter at some point or points than at others. By the operation of the "law of gravitation" the surrounding matter must be drawn toward each point of greater density, or center of condensation. Considering any one such center or nucleus, it is evident that the surrounding particles must be drawn directly toward it if they are at rest relative to the nucleus, but it is practically impossible that in a vast irregular mass like the one under consideration such a condition should obtain; the mutual attraction of the particles must induce motion, therefore the surrounding matter will have a velocity relative to the nucleus, and this, in conjunction with the force of gravity resident in the nucleus, must cause the particles to describe orbits around the latter, under the operation of well known laws of mechanics.

The orbit of any one particle, unimpeded by others, may have any position relative to a fixed plane through the centre of gravity of the nucleus, but it is obvious that in the congeries of nebulous matter described above, the individual particles cannot have perfect freedom of motion; in proportion to the density of the mass, impact among the particles must occur, and some will have their orbital velocity accelerated thereby, while others will be retarded in their courses; the latter must therefore fall more directly toward

the centre of attraction, or the nucleus. As the condensation increases the orbital motion of the separate particles will, by impact, tend to set up a rotation of the whole mass around a fixed axis, and a spheroid will be developed from the primitive irregular mass.

The fixed, or polar axis of this spheroid will have its position determined by the position of the majority of particles having the greatest freedom of motion, and the rotational velocity will depend upon the amount of orbital velocity possessed by these particles. Thus the fixed axis will be located in the matter having the least orbital motion, or among those particles which fall most directly toward the nucleus.

In a rotating spheroid derived from an irregular nebulous mass, minor or secondary centers of condensation may be developed at any point or number of points, in the same manner as that in which the primary center or nucleus was formed, and in like manner will surrounding particles gravitate toward these secondary centers and revolve, or tend to revolve, in orbits around them, the orbital revolution being finally transformed into axial rotation. From these secondary formations tertiary ones may be developed in an analogous manner. It is thus that, in all probability, our sun and the stars, which are only distant suns, have had their origin.

These secondary formations must, by reason of the rotation of the mass in which they are developed, revolve in orbits around the primary nucleus. In a dense nebulous mass the revolving particles must have their motions more or less affected by friction and impact among themselves; the motion of some being retarded or destroyed, they will tend to fall directly toward the primary center; while the smaller particles thus fall, the larger secondary formations must, by reason of the "living force" due to their mass and velocity, be enabled to overcome the resistance referred to, and retain nearly their original motion derived from the rotation of the parent mass; *i. e.* they will move in nearly circular orbits around the primary nucleus; the other and smaller aggregations of matter, less able to overcome the resistance, must move in orbits of very great eccentricity, in fact almost in straight lines. This matter thus falling down toward the

center of attraction, will leave the larger bodies revolving in clear space in nearly circular orbits. In any primitive irregular mass such as that just considered, there may be one or more than one center of condensation; if only one, a body like our sun will be developed therefrom, while if there be two or more such centers or nuclei, the result will be the formation of binary and multiple stellar systems.

I think that we can consider the solar system as a perfect exponent of the processes above described. The sun can be regarded as the result of the condensation of an indefinitely extended nebulous mass into a rotating spheroid; it is obvious that a congeries of matter formed from the slowly moving particles near the outermost limits of the primitive irregular nebula would, by the operation of gravity, move in orbits of very great eccentricity; we know that the comets and meteors move in just such orbits. It is a well established fact that nearly all the cometary and meteoric orbits which have been determined approximate very closely the parabolic form, but that portion of the orbit of any one of these bodies through which it can be traced even by the aid of powerful telescopes is comparatively so small that it is impossible, in most cases, to tell whether it is part of a parabolic curve, or an ellipse of very great eccentricity, although in many cases the ellipticity is determinable. In view of the above facts it may be regarded as very probable that most, if not all, comets and meteors have their origin in the solar system. It is true that in a very few cases hyperbolic elements have been found, but the nature of the data from which they were derived is such that more or less doubt attaches to them; but circumstances may be such that a body may come into our system from the outside and one formed in that system be expelled therefrom; such cases must, however, be very rare.

The major axis of the orbits of these bodies are almost invariably of enormous length, a fact which can be accounted for by this hypothesis which regards comets and meteors as being formed near the outer limits of the primitive indefinitely extended nebula which has condensed into what we call the sun. By reason of their formation in these outermost regions, where the motion of the primitive nebulous matter was not confined to any definite direction, the come-

tary and meteoric orbits can have, and we know they do have, any inclination between 0° and 180°; but in the case of bodies formed in the interior portions of the nebula, where the condensation has become so great that the original orbital revolution of the individual particles has been transformed into a rotation of the whole mass, the motion will be confined to a definite direction, viz, that of the motion of rotation; the inclinations will therefore be confined between the limits 0° and 90°.

The planets may be regarded as bodies formed around the minor, or secondary centers of condensation; they have by reason of their "living force" retained the motion imparted to them by the rotation of the original mass in which they were formed, while the smaller particles have fallen toward the primary nucleus, thus forming the sun as we know it, and leaving the larger masses, or the planets, revolving around the latter body. As eminent physicists have shown, it is to this falling or condensing matter that the sun's heat and light are due through the principle of the "conservation of energy." The moon and the satellites of the other planets may be regarded as the tertiary formations above alluded to, these formations having been developed from the secondary masses, or the planets, by the same process by which the latter have been formed from the primary mass.

This conception of the origin of the members of the solar system differs from the "nebular hypothesis," as usually stated, in that these bodies are here considered as developed, not from rings thrown off by "centrifugal force" from the rotating mass, but from the matter gathering around the minor centers of condensation or nuclei by the action of the "force of gravity" resident in these nuclei, the mode of formation being analogous to that through which the primary nucleus, or the sun, has been derived from the primitive nebula.

It is customary to style the "nebular hypothesis" a very beautiful and plausible conception, yet *only* a speculation. But is it not more than this? We have ocular evidence of the existence of irregular indefinitely extended masses of nebulous matter; the "force of gravity" is an established fact, and the law of its operation is accurately known. We also know from the principles of "mechanics" that this

force acting upon this matter must produce results such as I have described above. Therefore I think that we are warranted in regarding the origin of the "solar system" ascribed by the nebular hypothesis as the true one.

From what has been shown, we can plainly see that the motion of rotation is simply the derivative of orbital motion; therefore, since the latter is the result of the action of the force called "gravity," it follows that the effects of rotation, viz., sun spots, terrestrial storms, seismic phenomena and ocean currents, are primiarly due, as I have claimed at the beginning of this paper, to one cause, viz., "gravitation."

The rotational velocity of any cosmic body depends, as stated above, upon the original orbital revolution of the particles composing it, and the orbital velocity depends upon the degree of freedom of the particles to move. This freedom depends upon the density of the matter; therefore the velocity of rotation may be regarded as a function of the density; the greater the latter the less will be the freedom, and consequently the less will be the rotational velocity, and *vice versa*. In this connection, the following numerical facts tabulated below will, I think, be found remarkable:

| PLANET. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Mercury.......... | $\frac{1}{338}$ | 0°10′ | 1.12 | 1.00 | 1.06 | —0.06 |
| Venus.............. | $\frac{1}{291}$ | 0 12 | 1.03 | 0.98 | 1.02 | —0.04 |
| Earth.............. | $\frac{1}{296}$ | 0 12 | 1.00 | 1.00 | 1.00 | 0.00 |
| Mars................ | $\frac{1}{202}$ | 0 17 | 0.95 | 1.03 | 0.97 | +0.06 |
| Jupiter............ | $\frac{1}{16}$ | 3 35 | 0.24 | 0.41 | 0.49 | —0.08 |
| Saturn............. | $\frac{1}{12}$ | 4 47 | 0.13 | 0.44 | 0.36 | +0.08 |
| Uranus............ | $\frac{1}{14}$ | 4 06 | 0.17 | 0.40 | 0.41 | —0.01 |
| Neptune........... | ... | ...... | 0.16 | ...... | 0.40 | ...... |

Column 1 contains the values of the "compression" computed by the method I have given. Column 2 contains the angles by which gravity would deviate from the normal to the surface at the equator, if the planets had not attained a

figure of fluid equilibrium; it is the angle of which the "compression" is the sine, or $a = \frac{p}{r}$. Column 3 shows the value of the density of each planet, the earth's density being taken as the unit. Column 4 shows the rotational periods, that of the earth, the sidereal day, being taken as the unit. Column 5 contains the square root of the densities in column 3, and column 6 shows the differences between the observed rotational periods and the square root of the densities, taken in the sense, observatian—computation, or column 4—column 5; the differences are expressed in terms of the sidereal day. We thus see that the square root of the densities is nearly the same as the rotational period corresponding, a fact which, I think, corroborates my claim that these periods are functions of the densities.

The reader cannot fail to notice the distinct line of demarcation between the first four planets and the last four, a line which is also distinctly marked by the zone of the asteroids. Although we do not know from observation the rotational period of Neptune, yet, as its density is known, and since the rotational period is a function of the density, we can safely assume that it is nearly the same as the period of Uranus. This will give us compression for Neptune $= \frac{1}{10}$ and the corresponding angle $5°32'$.

The action generated by rotation in the fluid particles of a sphere is probably to a certain extent cumulative: Considering the equation $p = \frac{V^2r^2}{k^2}$, in which the first number represents, as has been shown, the radial or uplifting force, and also the equal force exerted at a right angle to the former, which latter force tends to produce motion in the direction of rotation, we can plainly see that for a constant velocity in the case of any given body, the forces represented by $p$ will depend upon $k$; were there no axial rotation these forces would be *nil*, but if a rotary velocity be impressed, they will come into existence, and for a uniform motion they will be constant, and equilibrium will exist as long as $k$ is not changed in value. The proximity of another cosmic body will effect a change in the value of $k$, and therefore of the forces; but if the perturbing body remain at a constant distance, equilibrium will again be established. It is only by the *variation* of the distance of the neighboring body that changes in the value of the forces can be caused and

equilibrium be rendered impossible. Look at the case of Jupiter and the sun; the great planet is not at a constant distance from the latter, but moves from aphelion to perihelion and back again in nearly twelve years, with all the regularity of a pendulum vibration; the value of $k$ for the sun, and therefore the forces represented by $p$, must vary with the same regularity within certain limits. When the planet is in perihelion $k$ will have its minimum value; then will the uplifting force and the pressure at a right angle to it, and tending to produce motion in the direction of the rotation be the greatest; on the other hand, when Jupiter is in aphelion, $k$ will be greatest, and the forces will have their minimum values. In the first case the tendency will be to cause the appearance of a maximum number of spots upon the sun, and in the last a minimum. The general effect of this action must be alternate expansion and contraction of the solar globe, within narrow limits, and this vibratory or undulatory motion must have a period corresponding to that of the disturbing body. Furthermore, this effect must be cumulative; the action generated during one swing of the planet from aphelion to perihelion and return may be very small, but that from many may be considerable. The other planets must also exert a similar influence, but in a less degree. When the planet is in aphelion the value of $k$ is greatest, and that of the forces least; in other words, the sun's force of gravity is at a maximum; the solar matter must therefore undergo condensation toward the center, during the progress of the planet from perihelion to aphelion, and expansion while the perturbing body is moving in the opposite direction. Since, according to the principle of the "conservation of energy," this condensation must generate heat, it follows that there should be a slightly greater emission of heat from the sun when the spots are at a minimum than when they appear in greatest numbers. The same is probably true of electric and magnetic action. Thus meteorological effects dependent upon this solar action might be expected to occur upon the earth. Observation seems to indicate that they do.

We can obtain a very simple yet clear exemplification of the action of the forces above referred to in producing sun-spots, etc., by means of the following experiment: If we

take a vessel of water, and place in the latter small particles of any buoyant substance, these particles to act as indices of the motion of the water, and then pour or force an additional quantity of water so that it will produce a rapid current eastward across the vessel, vortices will be seen to form on each side of the current; those on the north will rotate in a direction opposite to that of the hands of a watch, while a contrary movement will be observed on the south side; along the current no vortices will be formed. It is a significant fact that the sun-spots are not found upon the equator, but at some distance on either side of it, just as the vortices in the above experiment. The reason may be found in the hypothesis which I have advanced above, viz., that there is at times a greater *angular* velocity near the solar equator than toward the poles, or a current, in the direction of the rotation, along or parallel to the equator. Furthermore the terrestrial storms or cyclones have a rotary motion in the directions shown by the experiment.

If we examine the elliptic orbit which a particle of matter on the equatorial circumference of the earth would describe if free to move, which orbit I have shown at the beginning of this article, we will see that the major axis of this ellipse is equal to the mean radius of the earth, and that the angle $11'47''.5$ which gravity, on the equator, would make with the normal to the surface, if the original fluid matter of the earth had not attained a figure of equilibrium, is the same as the angle of the vertical in latitude $45°$ or the maximum angle; it is $16''.9$ greater than the value generally used, because that is computed from Bessel's value of the compression or $\frac{1}{299.98}$, while the former is derived from the compression form by the method I have given or $\frac{1}{295.52}$ which is nearly the same as Clarke's value derived from arcs of meridian. It is the angle of which the compression is the sine, or it can be derived by combining the resultant of the forces represented by $p$, with the whole force of gravity; it will, then, be the angle which this second resultant makes with the whole force.

A study of the orbit will disclose other interesting relations which connect this simple process for finding the "figure of the earth," with the more elaborate analytical methods employed by Clairaut and other eminent geometers,

for the same purpose. In closing I would say that while to many the claim set forth at the beginning of this paper, viz., that the diverse phenomena mentioned were due to one and the same determinable cause may have seemed preposterous, those readers who have possessed sufficient interest in the subject, and patience to follow closely and understandingly the development of my theme, must, I think, have arrived at a different conclusion.

Complexity in the appearance, but simplicity in the reality seems to be a characteristic of the workings of Nature, from the operations of whose law of "universal gravitation," these effects flow as inevitably and naturally as, by virtue of the same great law, the raindrop falls from the cloud, and the river flows to the sea.

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## THE AVERAGE PARALLAX OF STARS.

BY W. H. S. MONCK.

For THE MESSENGER.

Dr. Elkin's computation of the average parallax of stars of the first magnitude must have interested most of the readers of THE SIDEREAL MESSENGER, but the considerable differences between some of his results and those of previous observers seem to render it desirable, if possible, to solve the same problem by a different method. I think, moreover, that the average parallax of stars of the second magnitude would be a more soluble problem than the average parallax of stars of the first magnitude. For photometric researches have shown that stars ordinarily classed as of the first magnitude, may differ from each other by two to three magnitudes and even taking Dr. Elkin's list the extremes probably differ by nearly a magnitude and a half. This occurs with stars of the first magnitude only. Stars of the second magnitude moreover being more numerous, an average is more reliable. My present object, however, is only to suggest a different mode of computing such averages.

The principle of this method is as follows: The sun is a comparatively insignificant member of the stellar system, and situated at a great distance from its nearest neighbors. Therefore the stars on an average have no greater

tendency to approach or recede from the sun than to move at right angles to the joining line; and on a general average the motion in the line of sight will be equal to the motion at right angles to it. The former of these motions can be measured in miles per second by the spectroscope; the latter is known as the proper motion of the star and is usually measured by the number of seconds or fractions of a second described annually. If we know the average motions in these two directions for the stars of any magnitude we can obtain the average parallax by equating them. Of course this method may be wide of the truth in the case of any individual star because the true direction of that star's motion may be nearly in the line of sight or nearly at right angles to it, but errors of this kind will balance each other in the average result. Further, I know of no reason for thinking that the average velocities of stars of the first magnitude are either greater or less than those of stars of any other magnitude, and this *a priori* anticipation is, I think, confirmed by the results of spectroscopic measurements as far as they have gone. If so, we can arrive at an average velocity in the line of sight for all stars, and then determine the average parallax of the stars of any given magnitude from the average proper motion of the stars of that magnitude.

Considering the difficulty of making accurate spectroscopic measurements, and the conflicting results often arrived at in the case of the same star, it is much to be wished that we had more of them. I have not, however, in making a first rough calculation, used all the measures that are available, but confined myself to the Greenwich results as published in the last three volumes of the *Monthly Notices* of the Royal Astronomical Society. In 1885 there was an average motion of 30.2 miles per second for 47 stars; in 1886 an average of 22.6 for 45 stars, and in 1887 an average of 28.0 for 43 stars. A large proportion of the stars observed each year were identical, and the differences must have arisen in part from errors of observation. Until, however, we have better results deduced from measurements of a larger number of stars, I think the average velocity of a star in the line of sight may be taken at 26 to 27 miles per second; and I believe a separate examination of the stars of

the first magnitude would not have led to a materially different result as regards them. Equating this velocity with the proper motion, we obtain for the average parallax of a star of any given magnitude (in seconds) approximately 0.11 *a*, where *a* is the average proper motion (in seconds) for a star of that magnitude. The average proper motion of Dr. Elkin's ten stars is 0″.609, which gives an average parallax of 0″.067, a figure somewhat lower than has hitherto been assigned, but the general result of recent investigation has been to reduce our estimates of parallax.

I do not know of any table of the proper motions of the stars of the second (or of any higher) magnitude from which their average parallax could be deduced in this manner. According to the usual photometric scale, a difference of one magnitude indicates that the distance is increased by the multiplier 1.585, and the proper motion will naturally be diminished in the same ratio. On this assumption, taking the average parallax of a star of the first magnitude at 0″.067, we shall have for the second magnitude 0″.042, and for the third 0″.026, provided that no light is lost in transmission. If light is lost in transmission, however, the average distances will be less, and the average parallaxes and proper motions greater. Numerous and careful observations both of proper motion and of spectroscopic velocity are much to be desired.

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## TOTAL SOLAR ECLIPSE, JAN. 1, 1889.

THE EDITOR.

It is yet too soon to give more than a brief outline of the work undertaken during the total eclipse of Jan. 1, 1889. The long distance that many parties traveled, the time necessary to develope photographic plates and to prepare illustrations, make it impossible to give, in this number, the full report which was suggested last month.

It may, however, interest our readers to have an introductory statement, at least, of facts in hand concerning the location of various observing parties, the work undertaken and the probable results reached.

The following statement concerning observers, instruments, places of observation and work attempted was gathered in California from various sources, and from correspondence since our return home.

*Willows.* The Harvard College Observatory party were stationed at Willows in the Sacramento Valley, on the west side of the river. The party consisted of Wm. H. Pickering, chief, S. I. Bailey, Robert Black, E. S. King, from Harvard, and twenty-nine local assistants. Fourteen telescopes and cameras were employed, and eight spectroscopes. The first contact was lost by clouds. The duration of totality was reported to be one minute and eighteen seconds (which is evidently an error in transmitting the report). Eight photographs were secured with the thirteen-inch telescope, giving images two inches in diameter before enlargement. Nine were taken with the eight-inch camera. Twenty-five negatives were taken to measure the brightness of the corona and surroundings; five negatives to search for intra-Mercurial planets, and twenty to study the spectrum of the corona and determine its composition. These photographs are expected to reach from the yellow rays to the ultra violet. For the latter purpose the spectroscope with lenses and prisms composed exclusively of quartz were employed.

Seven observations were made with the photometer to measure the general illumination during totality. It was found lighter than during the eclipses of 1878 and 1886. The corona was similar to those of 1868 and 1878, but showed much more detail than the latter. It was an exceptionally fine corona, extending usually on one side to two solar diameters. Its striking characteristic was two forked wings of light. The polar rays were well defined and considerably shorter.

Professor W. Upton of Brown University, and A. L. Rotch of Blue Hill Observatory gave attention to meteorological observations at a little distance from the Harvard party. Results not learned.

*Cloverdale* was the point chosen by the Pacific Coast Amateur Photographers' Association under the direction of Mr. Burckhalter who himself used a 10½-inch Newtonian reflector with camera attached for photographic purposes. The party consisting of about forty persons succeeded in

making one hundred and sixty-seven negatives with cameras of various sizes. As we went to press a full description of the work of this enthusiastic party came to hand accompanied by a dozen photographs of the corona as taken by diferent persons of the party.

The Lick Observatory party were located at Bartlett Springs. At the time of first contact the sky was perfectly clear, and both Mr. Hill and Mr. Barnard observed it. Mr. Hill observed the remaining three contacts, Mr. Keeler saw remarkable changes in the length of the coronal lines. Mr. Barnard obtained nine photographs with three different cameras. Mr. Leuschener made seven measures of light during totality. Drawings and paintings of the corona were also made. At the Lick Observatory thirteen photographs were taken of partial phases.

*Norman.* A party of 300 excursionists by special train from San Francisco, Sacramento and other points sought to reach a point within the path of the total shadow, but the train being late failed to see the total phase of the eclipse.

*Healdsburg.* A person by the name of Professor G. E. Hall reported that twenty-two negatives were taken at Healdsburg. Streamers were seen at this place ten or twelve degrees long as reported in the *Examiner* of San Francisco.

It was also said that "the corona presented the color of deep red near the moon, then rose vermillion, shading into orange violet." Solar prominences and portions of the chromosphere were doubtless meant. The length of the streamers was greatly exaggerated in this report, probably five times their true length.

*Nelson* was the point chosen by Professor Lewis Swift, of Warner Observatory, Rochester, N. Y. His purpose was to search again for intra-Mercurial planets, but clouds and haze made this work impossible.

All four contacts were well observed, a chronometer watch previously set to the Lick Observatory time being used by N. B. Scott. Five very small colorless protuberances were seen, all having pointed apexes. Near the point of one was another detached from the sun. Bailey's beads were seen at the second and third contacts, but entirely unlike those seen at Denver in 1878. No chromosphere was visible, though looked for.

Mercury, Venus, Vega and Alpha Cygni were seen; the corona could not be drawn, but as seen through the telescope was not very extensive.

The first contact was at 12*h* 24*m* 36*s*; the second contact was at 1*h* 48*m* 29*s*; the third contact was at 1*h* 50*m* 25*s*; the fourth contact was at 3*h* 8*m* 14*s*. The duration of totality was one minute and fifty-six seconds.

*Chico.* The Carleton College party observed at this point. Professors Pearson and Wilson made twenty-one exposures, nine of which belonged to the total phase. Some of these photographs have been developed and turn out well, others show a disturbed telescope, and over exposure. Professor Payne examined the corona with a two inch telescope, and noticed the north polar rays curiously curved, saw two colored prominences on the western limb and a portion of the chromosphere in all its usual strong color. Drawings were made and all contacts were observed.

The beginning of totality was observed at 1*h* 42*m* 7*s*, and its end came at 1*h* 50*m* 2*s*, giving a duration of 1*m* 53*s*, four seconds less than the time computed for this point by the Lick Observatory.

Free hand sketches of the corona were drawn by several persons connected with our party. Some of these will be published later.

The corona as seen through the telescope was full of interesting details. We had time to examine only a part of it.

*Winnemucca* (Nev.) The weather was perfectly clear during the entire day. Professor H. A. Howe, of Denver University, with five assistants, observed the contacts, made drawings of the corona and did some photographic work.

Professor Elkin of the Yale Observatory also chose this point. He did not discover two comets as was erroneously reported at the time.

J. A. Brashear made drawings of the corona especially in the region of the south pole of the sun.

No appreciable change of temperature was noticed during the eclipse. Shadow bands were observed here. The corona was similar to that of 1878. The streamers extended from 3 to 4 diameters of the sun and red protuberances were strongly marked.

Chas. W. Irish, Surveyor General of Nevada, chose a point

on 120th meridian north of Reno. He made drawings of the corona, observed contacts, and secured several good photographs during totality. His results are important and will find place in the March MESSENGER.

Professor C. W. Pritchett, of Washington University, St. Louis, and his party were also very successful in their observations. Professor D. P. John, of DePauw University, Ind., was also somewhere in the path of totality. The results of his work we have not yet learned. There are many other observers whose work deserves mention, but want of space compels us to defer it at present.

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## NOTE ON THE ECLIPSE OF JAN. 1, 1889.

PROFESSOR DAVID P. TODD.*

For THE MESSENGER.

The clear skies everywhere prevalent along the belt of total eclipse on the afternoon of January 1st afforded a most favorable opportunity for the co-operation of volunteer observers who had received copies of the instructions for observing the eclipse prepared by myself under the direction of the Bache Trustees of the National Academy of Sciences. Several hundred pamphlets were distributed to the best addresses that could be secured, of persons within the path of the shadow from the Pacific Coast through California, Nevada, Idaho, Wyoming, Montana, Dakota and Manitoba. The returns from this expenditure already received are most gratifying. Only about one per cent of the observers remark any interference whatever from clouds. Practically the whole eclipse region was free from atmospheric obstructions, and even in Manitoba, near the point where the shadow left the earth and the sun was thus only a few minutes above the horizon, the reports I have received show that the observers had excellent conditions for this work.

It seemed best to confine the instructions to a very few points of scientific interest. So I selected five, (1) drawings of the entire corona, (2) drawings (telescopic) of the filaments about the solar poles, (3) sketches of the outlying streamers along the ecliptic (using an occulting disk), (4) ob-

* Director of Amherst College Observatory.

servations of the simple duration of totality along both edges of the shadow-track, (5) photographs of a standard object illuminated by the direct light of the corona.

These last which I regarded as of least importance, have apparently been least attractive to the amateur photographers. The plates I have received are not developed, and thus nothing is yet known as to the results.

Under (4), the observations appear to show no great error in the predicted position of the lunar shadow, though they cannot of course be definitely discussed until the exact longitude and latitude of the numerous observation points have been determined—a large work.

The drawings of class (1) are perhaps as diverse as those similarly obtained in the eclipses of 1869, 1878, and 1887; but the scores of sketches already received indicate a corona of unusual proportions and irregularity of figure. I shall discuss them uniformly with the Japan series of 1887 now in my hands, and the results seem likely to be of value, even as supplemental to whatever photographs have been secured. Certainly it will be determined whether, in future eclipses passing over inhabited regions, it will be worth the while to trouble the intelligent residents with coronal sketch-making. Should this note reach any person who has made a sketch of the corona at the late eclipse, and who has not forwarded it, he is invited to do so as early as practicable, and will receive in return a copy of the published report on all the observations which have been made in response to my instructions.

The drawings of class (2) are perhaps the most important of all, as even small telescopes and concentrated attention will bring out details of the complex polar filaments such as the photographs of previous eclipses have mostly failed to show. I should, perhaps, except the Krasnoiarsk negatives of 1887 from this statement; while the results of the best exposures of the present eclipse are, of course, unknown as yet. The case, however, seems to be so far quite as clearly in favor of the optical observer, as is the pictorial representation of the detail of sun-spots, where the photographic plate operates at a disadvantage which it is hard to see the way to overcome at present. It seems to me a matter for regret that more telescopes should not have been used in

this way. Most of the polar sketches already received are excellent, but there are not so many of them as I had hoped for.

With reference to the zodiacal streamers (3) the returns are very satisfactory, when one considers the extra trouble the intending observer must take to set up the occulting disk, adjust a mark for the position of the eye—not to mention the requirement that he should keep his eyes in entire darkness for ten or fifteen minutes before totality, and thus sacrifice all chance of seeing a part of the phenomenon of very great popular interest. I have already a goodly number of such sketches, and they show that many of the observers traced the streamers quite as far from the sun as Langley and Newcomb saw them at the discovery in 1878. The persistence of those puzzling objects at or near the epoch of minimum spots must be taken, I think, as strong evidence in support of the theory of a ring of meteoric or other matter surrounding the sun approximately equatorially; and the probable absence of which, during the time of maximum spots, has, in some not yet fully understood manner, something to do with the occurrence of this maximum. This last eclipse was so short that I shall not be surprised if the optical sketches of the streamers are found to show them farther out than even the best of the photographs do.

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## ASTRONOMY IN THE UNITED STATES.*†

T. H. SAFFORD, PH. D.

Half a century ago, then, American astronomy in a practical form was beginning to show itself. About Boston there were three or four amateur observers of a good deal of skill. One of the best was the chronometer maker, Willam Cranch Bond, who had a little private observatory in Dorchester; Paine and Bowditch were others. Peirce and Lovering were young professors at Harvard. Bowditch had published his translation of the Mècanique Cèleste, copies of which he generously gave to libraries and to mathematical students. At

* A discourse read June 25, 1888, to commemorate the fiftieth anniversary of the dedication of the Hopkins Observatory at Williams College, Williamstown, Mass.

† Continued from Vol. VII, p. 437.

New Haven there was much interest, and some effort to make valuable observations; and the college was graduating more young mathematicians than it had usually done.

In the government service were skilled observers, who had at their command fairly good instruments of moderate dimensions; but there was no permanent observatory at Washington, or elsewhere in the country. About this time Captain Wilkes's exploring expedition sailed on its long voyage around the world. Wilkes will be remembered by his seizure of the Trent, rather than by his earlier reputation as a scientific explorer. In these voyages it was intended to determine the longitude of many places by observations of the moon, and it became necessary to make similar observations on land at known places. A young naval officer, Lieutenant Gilliss, was instructed to make such observations. His transit instrument, of very modest dimensions, was set up on Capitol Hill at Washington, under a temporary shed; and a fine clock was placed along with it. There Gilliss observed very regularly from 1838 to 1842.

Similar observations were made at Dorchester by W. C. Bond, under contract with the Government. But these beginnings of astronomical works, which led later to the establishment of observatories, were themselves subsequent to the building of the Williams College Observatory by Albert Hopkins. Almost from its foundation our College has had instructors who were lovers of natural phenomena, and science has in a modest way been long encouraged here. Chester Dewey, an early professor in this College, was the first scientific lecturer I had the pleasure of hearing. He was teaching physics and chemistry in a little medical school in Vermont, and I well remember how I was interested in a lecture on heat which I was allowed to attend. In the very early time, years before, of his professorship here, he taught all the sciences of the ocurse, or nearly all; his specialty, later, was a branch of botany. Eaton and Emmons will also be remembered among our professors, as men of original views; but I think we are indebted to Albert Hopkins for much of the impulse toward the direct study of nature which has long prevailed here.

When Mark Hopkins was made President in 1836, his brother Albert had been some years an instructor in the

College. In 1834 he had gone abroad to procure philosophical apparatus, and learn something of the European methods of investigation and teaching. At that time the impulse to scientific study which was contemporaneous with the French Revolution, and which had continued through the Napoleonic wars, had spread over nearly all Europe. Even England had submitted to the continental ways of studying mathematics,—not quite completely, but still far enough to give a good deal of community of spirit between the English and foreign astronomers. In Germany and the Baltic provinces of Russia there were astronomers—Bessel, Struve, Gauss, Argelander, Encke,—who taught practical astronomy as a university discipline, and employed their observatories as practical means of impressing their theoretical lessons on the pupils. In England and, I think France, it was not so; theoretical mathematics was studied to the completion of the course in it, and was followed by the more abstract parts ofastronomy.

The pupils of the astronomers before mentioned were not very many, but yet enough to keep the subject alive, and gradually diffuse a knowledge of it through the higher schools. At Cambridge, in England, the mathematical instruction had little by little taken the form of training men to pass examinations in the mathematics, and the senior wranglership, or first place in mathematics, was the goal of the ambition of the ablest men in the university. Our American courses were in part copied from the English studies of the last century, and were, little by little, modified to suit our circumstances. But their adaptation was not perfect, partly because no definite idea was dominant.

At Dr. Mark Hopkins's entrance upon the presidency of Williams, in 1836, a new spirit soon manifested itself. His scheme of studies was well thought out, and the leading idea, that of making man himself the subject of study for the Senior year, tended to give the course a certain roundness and distinctness to the mind. He taught physiology as an introduction to philosophy; a natural thing for a trained physician to do, and it was a very advanced idea at the time. This new impulse seems to have led to the building of the Observatory; both brothers probably thought it would make, as it has done, the study more vivid and interesting.

I need hardly enlarge here upon the character of Albert Hopkins. All Williams men know how strong in all respects he was; what an admirable helper to his more widely celebrated brother; how high and pure his aims, how great a factor he was, especially in the religious life of the College, for so many years. But even as a young man he was deeply imbued with the love of nature. There was no one who did more to interest his students in all the Creator's wonderful works. To his initiative is due the first scientific expedition sent from this College; for many years he was the leader in the exploration of these hills, which has been so fruitful both of health and knowledge to the generation now middle-aged.

I presume that in 1834 he had arranged for the purchase or construction of the transit instrument and clock, the latter still in active employment as a time keeper for ordinary as well as as for scientific purposes.

During his visit to Europe, too, he undoubtedly learned much of the interest in the return of Halley's comet, expected to occur within a year; and on his coming back he soon began the construction of an observatory. He built this chiefly at his own expense, and partly with his own hands; he even worked in the stone-quarry, getting out its materials.

It is a quaint little structure, but well planned and built for its purpose. The ground plan is that of a central portion surmounted by a dome, with two wings; very much like many observatories then and now. It is still used for gazing at the heavenly bodies, and is useful for the students in a variety of ways. Its replacement for scientific purposes by an observatory upon a new site is due to the situation, now partly surrounded by trees; so that if the attempt had been made to mount in it the beautiful meridian instrument which Mr. Field gave the College in 1881, it would have been necessary to sacrifice many of the ornaments of the campus. The authorities were naturally unwilling to do this, and preferred to provide more room in a retired spot, and Mr. Field's great kindness was again manifested in providing the building,—the "Field Memorial Observatory." In 1869 he had founded the Professorship, and so gave Professor Hopkins release from other duties in his declining years.

The Hopkins Observatory was, as I have implied, the first in this country of a permanent character. Every such building previously erected or arranged for the purpose, was temporary in its very nature; there is no one of these now standing. Of course Rittenhouse, and that admirable observer, the elder Bond, and other astronomers, had their private observatories in connection with their houses; but our Professor was the first actually to erect an observatory for public purposes. It was chiefly built in 1837, and dedicated on June 12, 1838; it is the fiftieth year from this which we now commemorate.

I do not think that in so generously devoting his savings to the College for this purpose, Professor Hopkins intended making regular courses of observation. For this his duties were too multifarious; his teaching included at first all the mathematics and natural philosophy of the course; and practical astronomy is a profession by itself, usually requiring for its highest perfection the devotion of a life-time. There are those, it is true, who have become distinguished astronomers while engaged in other professions,—the musician, William Herschel, the physician, Olbers, the shipmaster and man of business, Bowditch. But Professor Hopkins felt his true mission to consist in moulding character by the influence, direct and indirect, of the religious life; he was ever an active missionary.

His idea was rather that of using the Observatory to make tangible his teaching of the science; to give the instruction emphasis and force by actual sight where the abstractions were too deep for the pupils' minds; and also to interest one or the other bright student to use the instruments for himself, and thus awaken slumbering talent.

In the history of American astronomy this first establishment of a permanent Observatory is a striking landmark. Up to that time all efforts to establish one had failed. People were too materially inclined, it would seem, to encourage such an ideal science. What was known of astronomy seemed far distant. Even the practical every-day uses of the science were overlooked or despised; I have read a surveyor's petition to Congress, begging to be released from the requirements to run due north and south lines; he lost too much time in watching for the Polar Star on foggy

evenings; he thought lines run in any direction would do as well, provided they were tolerably straight. Time-pieces were kept roughly correct by "noon-marks" and other rude contrivances, and few felt the need of more accurate subdivision.

Congress had sternly set its face against the establishment of an Observatory. The Coast Survey received its money on condition that none of it should be spent for any such purpose. The Survey had, it is true, collected transit instruments and telescopes, with which observations could be made; and the army engineers had also their little plant of similar apparatus.

Lieutenant Gilliss, as I have before mentioned, made astronomical observations from 1838 to 1842, in a cabin on Capitol Hill, and was enabled to show more or less of his work to visiting Congressmen, and to dispel in some degree their prejudices. In 1838, also, an Observatory was begun at Hudson, Ohio, under Elias Loomis, who observed pretty regularly for several years. A year or two later Sears C. Walker and E. O. Kendall built the Central High School Observatory of Philadelphia, and began observations and computations.

At West Point the need of an Observatory was strongly felt, and Professor Bartlett went abroad in 1840 to order instruments and visit observatories. On his return, rooms were provided for the instruments in the new library building of the school; in this we see the effect of the prejudice which would not allow a separate Observatory to be paid for out of public money.

Finally, in 1842, Congress authorized the building of a "Depot of Charts and Instruments;" the present Naval Observatory at Washington under a disguised name. It is one of the faults of our system of government, that appropriations are often made without a very distinct knowledge on the legislators' part of the use for which the money is intended. The astronomers of the Observatory were at first to be naval officers; partly of the line, lieutenants and passed midshipmen, partly the so-called professors of mathemathics. These were a small corps of educated men, whose duties had been to go to sea and teach the midshipmen navigation; their number became needlessly large when the

Naval Academy was founded, and the midshipmen concentrated at Annapolis; so that several of the "professors" were ordered to the Observatory. The corps is still kept up, and has contained many distinguished astronomers.

The next large Observatory founded was at Cambridge. In 1843 appeared a remarkable comet; probably a fragment of a much larger body which at some past time has been broken up by its near approach to the sun. It went within 100,000 miles of the sun's surface, and was subject to enomous heat and powerful attraction. It was visible in full daylight, as was the comet of 1882, which some of you may remember; probably not the same as the comet of 1843, but another broken piece of the same original body. In the study of the comet of 1843, Professor Benjamin Peirce was much interested, and he used his great eloquence to impress on the Boston men of wealth the need of a large Observatory.

Some time before this Mr. W. C. Bond had been invited to remove to Cambridge with his instruments, and a house belonging to Harvard College had been fitted up for him, so that there might be an Observatory at Cambridge, and, nominally at least, under college authority. Peirce's appeal was ably seconded by J. Ingersoll Bowditch, son of Nathaniel, and himself an astronomer of no mean attainments, but better known as an active business man in his father's footsteps. He has always shown a lively interest in the Observatory and all scientific enterprises about Boston; and by the efforts of Professor Peirce and Mr. Bowditch the money was raised for a great telescope.

The order was given in Europe for a refractor fifteen inches in diameter, equal to the largest then existing. It is still a comparatively large telescope; but our own opticians, as we shall see, have gone far beyond its dimensions. The Harvard College Observatory was built in the years before 1846 and the great telescope came in 1847. A few years later the indefatigable Peirce was laying the scientific foundations of the American Nautical Almanac; while his increasing reputation attracted about him a few mathematical students of high ability from various parts of the country, in addition to his college pupils.

Lieutenant (afterwards Admiral) C. H. Davis, a family

connection of Peirce, was the one who succeeded in persuading Congress to pay for the calculation of an American almanac for the sailors, and release us from a dependence upon foreign nations, which might be troublesome in case of war. The office of the Nautical Almanac was established—at first in Cambridge—under Davis's business management and Peirce's scientific control.

Meanwhile the Coast Survey had gone steadily on; after Hassler's death it was placed under the superintendency of Professor Bache, of Philadelphia, a great-grandson of Franklin, and a distinguished graduate of West Point. From Franklin he seemed to have inherited both scientific ability and executive and diplomatic capacity to a high degree.

(TO BE CONTINUED.)

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## PROPER MOTION OF SOME DOUBLE STARS.

F. P. LEAVENWORTH.*

For THE MESSENGER.

From recent observations made at this Observatory I find a number of Burnham's doubles appear to be in motion, while several, supposed to be in motion, appear fixed. Of these without doubt β 80 and β 83 are moving; the remainder are more uncertain and some, which are not included here on account of greater uncertainty, are possibly in motion.

I am much indebted to K. J. Tarrant, H. C. Wilson, N. M. Parrish, S. W. Burnham and J. G. Porter for copies of unpublished measures and for proper motion of principal stars.

The names of observers have been abbreviated as follows:

| | | | | | |
|---|---|---|---|---|---|
| B | denotes | Burnham. | Mc | denotes | McCormick Observers. |
| Cin | " | Cincinnati Observers. | Mor | " | Morrison Observers. |
| De | " | Dembowski. | T | " | K. J. Tarrant. |
| Hl | " | Asaph Hall. | W | " | H. C. Wilson. |
| L | " | F. P. Leavenworth. | | | |

β 395. $0h\,31m$ $-25°\,26'$.

| yr. | ° | | ″ | | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 76 | 135 | ± | 0.5 | ± | — | B | 86 | 104.7 | 0.65 | 2 | Mc |
| 79.72 | 336.6 | | 0.31 | | — | Cin | 88.87 | 107.2 | 0.66 | 2 | L |

* Director of the Haverford College Observatory.

The Cincinnati measure does not seem to have been published in the Cincinnati Publications. The double is no doubt a binary, as otherwise, proper motion would in the interval 1886-88 change the distance some 2.8″.

β 4. 1*h* 17*m* +10° 58′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.6 | 68 | | | De | 86.71 | 74.2 | 0.43 | | Mc |
| 79.66 | 119.1 | 0.52 | 1 | Cin | 88.83 | 61.0 | 0.41 | 3 | L |
| 80.06 | 77.2 | 0.53 | 4 | B | | | | | |

The motion of this difficult pair is doubtful. With the 10-inch glass of this Observatory and the highest power 400, it is barely elongated. Its distance can hardly be greater than 0.4″. With the 26-inch at the McCormick Observatory and a high power, it is an easy object on a good night. The observation of 86.71 is, no doubt, much more accurate than that of 88.83.

β 8. 2*h* 15*m* +8° 20′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.30 | 200.5 | 0.96 | 4 | De | 88.88 | 207.8 | 1.06 | 2 | L |
| 80.92 | 204.3 | 0.90 | 1 | B | | | | | |

β 83. 2*h* 40*m* −5° 28′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 76.02 | 121.3 | 1.40 | 4 | De | 86 | 115.8 | 0.98 | 6 | Mc |
| 77.91 | 122.2 | 1.00 | 3 | Cin | 88.87 | 109.2 | 1.00 | 2 | L |

β 89. 5*h* 31*m* −1° 30′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.68 | 344.2 | 0.55? | 3 | De | 79.61 | 2.0 | 0.73 | 5 | B |
| 78.40 | 356.1 | 0.81 | 3 | Cin | 88.47 | 0.7 | 0.89 | 2 | L |

The first measure is very poor, the individual observations differing as much as 12°. If this were rejected the remaining measures would agree fairly well. However, it is possible that Dembowski's measure is approximately correct, and that the distance was smaller when measured by him than it now is.

β 916. 11*h* 8*m* −14° 47′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 80.33 | 8.1 | | 1 | Mor | 86.31 | 357.4 | 0.80 | 1 | W |
| 83.26 | 7.0 | 0.5 | 1 | W | 88.16 | 357.4 | 0.65 | 1 | L |

β 929. 12*h* 58*m* −3° 1′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 79.40 | 229.4 | 0.48 | 3 | B | 88.32 | 221.6 | 0.62 | 2 | L |
| 88.25 | 219.1 | 0.54 | 5 | T | | | | | |

The Cape Catalogue gives a proper motion $\Delta\alpha - 0.004s$, $\Delta\delta - 0.03''$, which does not explain the change in position angle.

β 106. 14*h* 43*m* −13° 39′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.60 | 335.0 | 1.38 | 5 | De | 86.39 | 337.2 | 1.52 | 4 | T |
| 78.47 | 334.9 | 1.86 | 5 | Cin | 88.35 | 339.9 | 1.63 | 3 | L |
| 85.28 | 337.0 | 1.56 | 1 | W | | | | | |

Position angle seems to be increasing at the rate of 0.4° per year.

β 239. 14*h* 52*m* −27° 10′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 74.50 | 123.7 | 0.8 | 5 | B | 80.90 | 131.9 | 0.99 | 6 | B |
| 80.05 | 128.3 | 0.90 | 6 | Cin | 88.43 | 128.3 | 0.95 | 1 | L |

The earlier observations give indication of motion but the last one makes it doubtful.

β 119. 14*h* 59*m* −6° 33′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.90 | 313.0 | 1.51 | 4 | De | 87.89 | 307.4 | 1.58 | 7 | T |
| 78.60 | 311.1 | 1.41 | 5 | Cin | 88.45 | 306.2 | 1.60 | 2 | L |

There seems to be a retrograde motion in position angle of 0.5° per year.

β 120. A B 16*h* 5*m* −19° 9′.

| yr. | ° | ″ | No of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 74.40 | 357.7 | | 6 | B | 80.58 | 6.0 | 0.73 | 15 | B |
| 76.35 | 0.0 | 0.73 | 13 | De | 84.40 | 3.4 | 0.5 | 1 | W |
| 78.70 | 2.0 | 0.80 | 11 | Cin | 86. | 7.2 | 0.65 | | Mc |
| 79.59 | 5.3 | 0.74 | 1 | Hl | 87.63 | 5.4 | 1.00 | 5 | T |
| 80.54 | 0.9 | 0.54 | 6 | Mor | 88.39 | 4.6 | 0.80 | 3 | L |

Probably a slight increase in position angle. The differences may be due to accidental errors of observation. This is more likely as the errors are large; no doubt on account of the closeness, brightness, and southern declination of the star.

β 631. 17*h* 34*m* −0° 35′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 79.55 | 253.0 | 0.39 | 4 | B | 88.51 | 238.8 | 0.40 | 3 | L |

Other observations are needed to confirm this change.

β 142. 19*h* 22*m* −12° 23′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 74.08 | 317.7 | 1.38 | 5 | De | 86. | 327.6 | 1.68 | 1 | Mc |
| 78.89 | 319.6 | 1.37 | 6 | Cin | 88.53 | 328.0 | 1.59 | 3 | L |
| 82.53 | 324.4 | 1.68 | 2 | W | 88.70 | 326.3 | 1.47 | 3 | T |

Motion very probable.

β 80. 23*h* 13*m* +4° 45′.

| yr. | ° | ″ | No. of Obs. | | yr. | ° | ″ | No. of Obs. | |
|---|---|---|---|---|---|---|---|---|---|
| 75.80 | 300.4 | 1.07 | 4 | De | 86. | 316.1 | 0.48 | 1 | Mc |
| 77.79 | 306.1 | 1.24 | 2 | B | 88.76 | 319.6 | 0.84 | 3 | L |
| 81.69 | 312.2 | 0.91 | 3 | B | | | | | |

Position angle changing at the rate of 1.5° per year. The distances are very discordant. There can be little doubt of its binary nature, as the proper motion, according to Argelander, is 0.56″. Mr. Burnham in Washburn Publications first called attention to the motion of this double star.

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## CURRENT INTERESTING CELESTIAL PHENOMENA.

### THE PLANETS.

*Mercury* during the latter part of February and the first part of March will rise about an hour before sunrise, in this latitude, but will not reach a sufficient altitude in that time for good observations. He will be at greatest elongation, 27° 53′ west, from the sun March 13. There will be no bright stars in the vicinity of Mercury so that there can be no mistake in identifying the planet, if it be seen at all, in the morning twilight near the southeast horizon.

*Venus* will be at greatest elongation east from the sun, 46° 36′, February 18, setting then over four hours later than the sun. The phase then will be slightly gibbous, 0.514 of the disk being illuminated. This month and the next will be the most favorable for examining the surface of Venus, and every effort should be made to discover any permanent markings and determine the rotation period of the planet. The diameter of the disk will be 24.6″, Feb. 15 and 34.6″ March 15.

*Mars* is still visible in the evening twilight but is so far from the earth that nothing of detail can be seen on his surface. Some excellent maps of this planet by Schiaparelli have been published in the last number of *L'Astronomie* (January, 1889.)

*Jupiter* may be seen in the southeast in the morning, rising three hours before the sun. He is in the constellation of Sagittarius and is brighter than any of the surrounding stars.

*Saturn* may now be observed during the whole night, the best hours being from 8 o'clock to midnight. To find Saturn at 8 o'clock look toward the east about half way from the horizon to the zenith; the brightest object is Saturn, whose steady, yellow light is easily recognized. Below Saturn is the well known group, the Sickle, a part of the constellation Leo. The elevation of the plane of Saturn's rings above the earth is increasing slightly at present, being now 15°, so that the rings are coming into better position for observation. The outer major axis of the rings is a little over 45″. Saturn will be in conjunction with the moon, 1° south, at midnight March 13.

*Uranus* may be found in the east after 10 o'clock P. M. in the constellation of Virgo about 3° north of Spica.

*Neptune* is past the best point for observation this year, but may still be seen with a telescope of sufficient power until nearly midnight.

| | R. A. | Decl. | Rises. | Transits. | Sets. |
|---|---|---|---|---|---|
| | h m | | h m | h m | h m |
| MERCURY. | | | | | |
| Feb. 24 | 21 19.5 | −12 54 | 5 49 A.M | 11 00.5 A.M. | 4 12 P.M. |
| Mar. 1 | 21 19.5 | −14 05 | 5 34 " | 10 40.8 " | 3 47 " |
| 5 | 21 26.5 | −14 27 | 5 27 " | 10 32.0 " | 3 37 " |
| 10 | 21 41.6 | −14 14 | 5 21 " | 10 27.4 " | 3 33 " |
| 15 | 22 01.7 | −13 19 | 5 18 " | 10 27.8 " | 3 38 " |
| VENUS. | | | | | |
| Feb. 24 | 1 21.2 | +11 08 | 8 13 A.M. | 3 01.5 P.M. | 9 50 P.M. |
| Mar. 5 | 1 51.1 | +15 02 | 7 51 " | 2 53.8 " | 10 00 " |
| 15 | 2 20.5 | +18 46 | 7 24 " | 2 45.8 " | 10 08 " |
| MARS. | | | | | |
| Feb. 24 | 0 21.7 | + 1 51 | 7 52 A.M. | 2 02.2 P.M. | 8 13 P.M. |
| Mar. 5 | 0 46.7 | + 4 38 | 7 30 " | 1 51.6 " | 8 13 " |
| 15 | 1 14.3 | + 7 37 | 7 06 " | 1 39.9 " | 8 14 " |
| JUPITER. | | | | | |
| Feb. 24 | 18 13.9 | −23 05 | 3 30 A.M. | 7 55.3 A.M. | 12 20 P.M. |
| Mar. 5 | 18 19.8 | −23 03 | 3 00 " | 7 25.6 " | 11 51 A.M. |
| 15 | 18 25.3 | −23 01 | 2 23 " | 6 48.7 " | 11 14 " |
| SATURN. | | | | | |
| Feb. 24 | 9 12.8 | +17 21 | 3 37 P.M. | 10 51.8 P.M. | 6 07 A.M. |
| Mar. 5 | 9 10.3 | +17 32 | 2 58 " | 10 13.9 " | 5 30 " |
| 15 | 9 08.0 | +17 42 | 2 16 " | 9 32.3 " | 4 49 " |
| URANUS. | | | | | |
| Feb. 24 | 13 20.7 | − 7 49 | 9 26 P.M. | 2 59.0 A.M. | 8 32 A.M. |
| Mar. 5 | 13 19.7 | − 7 43 | 8 50 " | 2 22.7 " | 7 55 " |
| 15 | 13 18.4 | − 7 35 | 8 09 " | 1 42.0 " | 7 15 " |
| NEPTUNE. | | | | | |
| Feb. 24 | 3 51.0 | +18 27 | 10 11 A.M. | 5 30.9 P.M. | 12 51 A.M. |
| Mar. 5 | 3 51.5 | +18 29 | 9 36 " | 4 56.0 " | 12 16 " |
| 15 | 3 52.2 | +18 32 | 8 57 " | 4 17.4 " | 11 38 " |

THE SUN.

| | R. A. h m | Decl. | Rises. h m | Transits. h m | Sets. h m |
|---|---|---|---|---|---|
| Feb. 24 | 22 32.5 | — 9 11 | 6 46 A.M. | 12 13.3 P.M. | 5 40 P.M. |
| Mar. 1 | 22 51.4 | — 7 18 | 6 38 " | 12 12.4 " | 5 47 " |
| 5 | 23 06.2 | — 5 45 | 6 [illegible]1 " | 12 11.5 " | 5 52 " |
| 10 | 23 24.7 | — 3 48 | 6 22 " | 12 10.3 " | 5 59 " |
| 15 | 23 43.0 | — 1 50 | 6 09 " | 12 08.9 " | 6 09 " |

**Occultations Visible at Washington.**

| Date. | Star's Name. | Magni-tude. | IMMERSION. Wash. Mean T. h m | IMMERSION. Angle f'm N. P't. ° | EMERSION. Wash. Mean T. h m | EMERSION. Angle f'm N. P't. ° | Dura-tion. h m |
|---|---|---|---|---|---|---|---|
| Feb. 23 | 58 Ophiuchi | 5½ | 15 01 | 90 | 16 00 | 302 | 1 00 |
| Mar. 8 | B. A. C. 1468 | 6½ | 8 32 | 125 | 9 30 | 219 | 0 57 |
| 8 | *i* Tauri | 5½ | 11 28 | 130 | 12 10 | 221 | 0 42 |
| 11 | 63 Geminorum* | 5½ | 12 50 | 89 | 13 47 | 293 | 0 57 |

**Phases of the Moon.**

| | Central Time. d h m |
|---|---|
| Last Quarter | Feb. 22 5 55 P.M. |
| New Moon | Mar. 1 4 01 P.M. |
| First Quarter | " 9 11 59 A.M. |

**Elongations and Conjunctions of Saturn's Satellites.**

[*Central Time; E = Eastern elongation, W = Western elongation, S = Superior conjunction, I = Inferior conjunction.*]

JAPETUS.

Feb. 17, W March 8, S

TITAN.

| d h | | d h | | d h | |
|---|---|---|---|---|---|
| Feb. 18, 2 A. M. | I | Mar. 1, MIDN. | E | Mar. 13, 10 P. M. | S |
| 22, 1 A. M. | W | 5, 11 P. M. | I | | |
| 25, MIDN. | S | 9, 10 P. M. | W | | |

RHEA.

| d h | | d h | | d h | |
|---|---|---|---|---|---|
| Feb. 17, 12.1 A. M. | E | Feb. 26, 12.6 A. M. | E | Mar. 7, 1.2 A. M. | E |
| 21, 12.4 P. M. | E | Mar. 2, 12.9 P. M. | E | 11, 1.5 P. M. | E |

DIONE.

| d h | | d h | | d h | |
|---|---|---|---|---|---|
| Feb. 18, 12.9 A. M. | E | Feb. 28, 11.5 P. M. | E | Mar. 9, 4.4 A. M. | E |
| 20, 6.5 P. M. | E | Mar. 3, 5.1 P. M. | E | 11, 10.1 P. M. | E |
| 23, 12.2 P. M. | E | 6, 10.8 A. M. | E | 14, 3.7 P. M. | E |
| 26, 5.8 A. M. | E | | | | |

TETHYS.

| d h | | d h | | d h | |
|---|---|---|---|---|---|
| Feb. 17, 10.9 A. M. | E | Feb. 26, 9.4 P. M. | E | Mar. 8, 7.8 A. M. | E |
| 19, 8.2 A. M. | E | 28, 6.6 P. M. | E | 10, 5.1 A. M. | E |
| 21, 5.5 A. M. | E | Mar. 2, 3.9 P. M. | E | 12, 2.4 A. M. | E |
| 23, 2.8 A. M. | E | 4, 1.2 P. M. | E | 13, 11.7 P. M. | E |
| 25, 12.1 A. M. | E | 6, 10.5 A. M. | E | 15, 8.9 P. M. | E |

*Ephemeris of Comet e 1888* (*Barnard Sept. 2.*) From the second series of Elements of Berberich as given in A. N. 2862, I have computed the following ephemeris:

* A multiple star.

| | R. A. | Decl. | log. r | log. Δ |
|---|---|---|---|---|
| | h m s | ° ′ | | |
| 1889 Jan. 1.5 | 0 17 6 | −7 17.1 | 0.2676 | 0.2463 |
| 3.5 | 13 29 | −7 10.6 | 0.2664 | 0.2578 |
| 5.5 | 10 10 | −7 3.6 | 0.2653 | 0.2690 |
| 7.5 | 7 8 | −6 56.2 | 0.2643 | 0.2798 |
| 9.5 | 4 20 | −6 48.5 | 0.2633 | 0.2903 |
| 11.5 | 0 1 47 | −6 40.5 | 0.2625 | 0.3005 |
| 13.5 | 23 59 27 | −6 32.2 | 0.2617 | 0.3103 |
| 15.5 | 57 19 | −6 23.7 | 0.2610 | 0.3197 |
| 17.5 | 55 22 | −6 15.1 | 0.2604 | 0.3288 |
| 19.5 | 53 34 | −6 6.3 | 0.2598 | 0.3375 |
| 21.5 | 51 56 | −5 57.4 | 0.2594 | 0.3459 |
| 23.5 | 50 26 | −5 48.3 | 0.2590 | 0.3540 |
| 25.5 | 49 4 | −5 39.1 | 0.2587 | 0.3617 |
| 27.5 | 47 50 | −5 29.8 | 0.2585 | 0.3691 |
| 29.5 | 46 41 | −5 20.5 | 0.2584 | 0.3762 |
| 31.4 | 45 39 | −5 11 2 | 0.2584 | 0.3289 |
| Feb. 1.5 | 23 45 10 | −5 6.5 | 0.2584 | 0.3862 |
| 3.5 | 44 16 | −4 57.0 | 0.2585 | 0.3925 |
| 5.5 | 43 27 | −4 47.5 | 0.2587 | 0.3985 |
| 7.5 | 42 43 | −4 38.0 | 0.2590 | 0.4042 |
| 9.5 | 42 2 | −4 28.4 | 0.2593 | 0.4096 |
| 11.5 | 41 25 | −4 18.8 | 0.2598 | 0.4147 |
| 13.5 | 40 52 | −4 9.3 | 0.2603 | 0.4195 |
| 15.5 | 40 22 | −3 59.7 | 0.2609 | 0.4241 |
| 17.5 | 39 54 | −3 50.1 | 0.2616 | 0.4284 |
| 19.5 | 39 29 | −3 40.5 | 0.2624 | 0.4324 |
| 21.5 | 39 6 | −3 30.9 | 0.2633 | 0.4361 |
| 23.5 | 38 45 | −3 21.3 | 0.2642 | 0.4396 |
| 25.5 | 38 27 | −3 11.7 | 0.2652 | 0.4428 |
| 27.5 | 38 9 | −3 2.1 | 0.2663 | 0.4458 |

The light of the comet is diminishing so slowly that it will be visible for a long time to come. O. C. WENDELL.

Harvard College Observatory, 1889, Jan. 12.

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*Note on the 279th Asteroid.* The circular of the Berlin Astronomical Year Book, No. 332, has just brought me the elements of this recently discovered member of the planetary cluster between Mars and Jupiter.* These results, calculated by H. Lange from the observations of Oct. 25, Nov. 9 and Nov. 27, have the following points of interest:

1. The orbital plane is nearly coincident with that of the ecliptic; the inclination being only 2°24′.

2. The eccentricity is 0.1762.

3. Its mean distance, 4.268, is twice that of No. 149, the innermost of the group; its aphelion distance, 5.02, is nearly the same as the present perihelion of Jupiter.

4. This asteroid is exterior to the space in which the period of a planet would be to that of Jupiter in the ratio of 2 to 3; a ratio of the first order.

* I am at present without access to astronomical works.

5. The breadth of the zone, from the innermost perihelion to the aphelion of No. 279, is equal to the entire interval between the orbits of Mars and Jupiter.

6. The period is 3220 days = 8.817 years.

7. As the 279th asteroid may approach indefinitely near to Jupiter, the question of its perturbation is one of great interest. Is its motion stable, or are the form and dimensions of its orbit liable to great variations?

DANIEL KIRKWOOD.

Riverside, California, Jan. 1, 1889.

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*Discovery of Comet Brooks—a of 1889.* While sweeping the eastern heavens this morning as near as possible to the sun, I discovered a new comet, in Right Ascension 18*h* 4*m*; declination south 21° 20′. It is a faintish, nearly round nebulosity, with slight central condensation. I caught it in the short interval between the disappearing moon and the coming dawn. I had but a few minutes to do my work, but fortunately the comet was in a well marked field of stars so that its motion, which I found to be rather rapid westerly, was detected in a few minutes of intent gazing, as the day dawn extinguished the light of the comet.

WILLIAM R. BROOKS.

Smith Observatory, Geneva, N. Y., Jan. 15, 1889.

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*Comet* 1888 V (*f*, Barnard, Oct. 30). I have computed the following ephemeris from elements published in the *Astronomical Journal*, No. 187, upon observations of November 1, 11, 21, December 1, 13.

The equatorial heliocentric co-ordinates referred to 1889.0 are:

$$x = [0.102603]\ \sin^2 \tfrac{1}{2} v\ \sin(174^\circ\ 3'\ 35''.2 + v)$$
$$y = [0.157478]\ \sin^2 \tfrac{1}{2} v\ \sin(\ 69\ 41\ 51\ .2 + v)$$
$$z = [0.002992]\ \sin^2 \tfrac{1}{2} v\ \sin(314\ 57\ \ 2\ .6 + v)$$

Ephemeris for Greenwich mean midnight:

| 1889 | h m s | ° ′ | log. $r$ | log. $\Delta$ | L. |
|---|---|---|---|---|---|
| Jan. 9 | 10 23 13 | + 7 22.4 | 0.3435 | 0.1452 | 0 92 |
| 11 | 21 58 | 8 28.1 | | | |
| 13 | 20 36 | 9 34.6 | .3506 | .1440 | .90 |
| 15 | 19 7 | 10 41.9 | | | |
| 17 | 17 30 | 11 49.6 | .3577 | .1444 | .87 |
| 19 | 15 48 | 12 57.6 | | | |
| 21 | 13 59 | 14 5.7 | .3647 | .1466 | .83 |
| 23 | 12 5 | 15 13.6 | | | |

| 1889 | h m s | ° ″ | log. r | log. Δ | L. |
|---|---|---|---|---|---|
| Jan. 25 | 10 10 5 | 16 21.1 | .3717 | .1506 | .79 |
| 27 | 8 1 | 17 27.9 | | | |
| 29 | 5 54 | 18 33.8 | .3785 | .1564 | .75 |
| 31 | 3 45 | 19 38.6 | | | |
| Feb. 2 | 10 1 30 | 20 42.2 | .3854 | .1640 | .70 |
| 4 | 9 59 15 | 21 44.2 | | | |
| 6 | 56 59 | 22 44 5 | .3921 | .1734 | .65 |
| 8 | 54 43 | 23 43.0 | | | |
| 10 | 52 27 | 24 39.5 | .3988 | .1844 | .60 |
| 12 | 50 12 | 25 33.9 | | | |
| 14 | 47 59 | 26 26.1 | .4054 | .1968 | .55 |
| 16 | 45 48 | 27 16.0 | | | |
| 18 | 43 40 | 28 3.7 | .4120 | .2104 | .50 |
| 20 | 41 35 | 28 49.1 | | | |
| 22 | 39 35 | 29 32.1 | .4184 | .2250 | .45 |
| 24 | 37 40 | 30 12.8 | | | |
| 26 | 35 49 | 30 51.2 | 0.4248 | 0.2404 | 0.41 |
| 28 | 9 34 4 | +31 27.3 | | | |

Light on Nov. 1 = 1

W. C. W.

*Seven Eclipses in One Calendar Year.* As a result of an investigation suggested by Mr. F. H. Burgess' communication in the SIDEREAL MESSENGER for January, I find two calendar years of this century within which there were seven eclipses: 1805 and 1823.

The series for 1805 is as follows:

| DATE. | ECLIPSE. | DATE. | ECLIPSE. |
|---|---|---|---|
| Jan. 1 | Sun. | July 11 | Moon. |
| Jan. 15 | Moon. | July 26 | Sun. |
| Jan. 30 | Sun. | Dec. 20–1 | Sun. |
| June 26–7 | Sun | | |

It is well known that eclipses repeat themselves in a period of eighteen years and ten or eleven days, known as the Saros. Accordingly, if we carry forward the above set of eclipses one period by adding eighteen years and eleven days, we obtain a repetition of them:

| DATE. | ECLIPSE. | DATE. | ECLIPSE. |
|---|---|---|---|
| 1823 Jan. 12 | Sun. | 1823 July 23 | Moon. |
| " Jan. 26 | Moon. | " Aug. 6 | Sun. |
| " Feb. 11 | Sun. | 1824 Jan. 1 | Sun. |
| " July 8 | Sun. | | |

Examining more closely the time of the last eclipse, it will be seen that its beginning occurred at 53 minutes past 5 o'clock (Greenwich mean time) on the morning of Jan. 1, 1824. If the day begins at 180° from Greenwich, at all places between 88° 15′ (= $5h\ 53m$) and 180° longitude west from Greenwich, the eclipse began before midnight (local time) of Dec. 31st; *i.e.* at these places seven eclipses occurred

within the calendar year. It may appear ungracious to note that there will be no eclipse on Feb. 24, 1895, as stated by Mr. Burgess; more particularly so, as by using that date as a starting point and carrying back his series five periods (90 years and 54 days), I was able to obtain the above information. The Saros does not admit of an exact application without the necessary calculations. I cannot speak positively, but am lead to believe that there will be an eclipse of the sun July 18, 1917. If so seven eclipses in one calendar year will next occur in 1917.

We came within an ace of having seven eclipses in 1852; but to explain would trespass still more on your valuable space. R. W. PRENTISS.

Washington, D. C., Jan. 10, 1889.

*Answer to Query 19.* The full moon runs high in winter and low in summer for two reasons. First, because we are in the earth's northern hemisphere. This causes the moon to run high when north of the celestial equator, and low when its declination is south. Secondly, the sun and moon both move nearly in the ecliptic, and a full moon can only occur when that body is in the opposite part of the heavens from the sun. Consequently in winter, when the sun is south of the equator, the full moon must appear to "run high." In summer the positions of the two bodies are reversed, the sun being in north and the full moon in south declination; therefore the latter "runs low." This applies only to the northern hemisphere of the earth, as in southern latitudes the conditions are contrary. There the full moon "runs high" in summer and low in winter. ***

*Query 20.* Are the satellites of Mars of meteoric origin, or will the Nebular Hypothesis account for them? L. F. C.

21. What is the cause of the polar filaments, so called, in the corona of the sun as seen in the January eclipse? P. W.

22. The papers say that some observers at the late total solar eclipse saw what they call shadow bands in motion during totality. What are they, and what caused them?

23. What are the relative merits of reflecting and refracting telescopes of the same aperture? A. B. D.

## EDITORIAL NOTES.

The all absorbing topic of the last month has been the eclipse of Jan. 1, and judging from the letters and reports already in hand opportunities for study of it were exceptionally good and the results obtained very encouraging.

January 28, this later report was received from Professor H. S. Pritchett, Observatory of Washington University, St. Louis. He says: "I took with me, as you perhaps know, one of the 6-inch equatorial cameras belonging to the government. Professor Engler and Professor Nipher of Washington University accompanied me and also Professor Charroppin of the St. Louis University as photographer. We secured excellent observations of all the contacts except the first, and six fine negatives of the corona. The negatives show a great deal of detail. The polar filaments are very strongly marked. Observing the coronal streamers with the aid of a disc sixty feet away Senor Valle, who also joined my party, was able to trace them three degrees from the sun. Hope to send you a complete report later."

*The Eclipse of the Moon* on the night of January 16 was observed at Carleton College Observatory. The night was cold and windy, and thin clouds were continually passing. Nothing of peculiar interest was noticed in the aspect of the lunar surface during eclipse. Four photographs were taken, two at the maximum phase, and two near the end of the eclipse.

*Brilliant Venus.* Some friend, having the initials P. B. S., claims to have seen Venus with the naked eye Jan. 1 and 14, at the hours respectively of half past one and half past twelve in the afternoon. This may be possible, but it is also certainly true that our friend has unusual powers of vision. As Venus nears the earth, this month will afford excellent opportunity for observation.

Professor Brooks, director of the Smith Observatory, Geneva, N. Y., secured the first contact of the eclipse of Jan. 1, 1889, at 4*h* 31*m* 5*s*, standard Eastern time. The sun's disc was conspicuously notched as it sank below the horizon.

Professor John G. Hagen, S. J., formerly of the Observatory of the College of the Sacred Heart, Prairie du Chien, Wis., has been recently called to the directorship of the Observatory of Georgetown College, Washington, D. C. His great interest in practical astronomy has been evinced by his work in connection with the Washburn Observatory, his independent observations, and, not least, by his thoughtful communications to the MESSENGER. We wish him abundant success in his new position, as he richly deserves.

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*H. P. Tuttle*, of Washington, D. C., has been giving some attention to the observation of comets recently, with the 9.6-inch equatorial of the Naval Observatory. Comet *f* 1888 he could easily see in a 2.6-inch field, but finds it difficult to observe with bright wires.

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On the day of the total solar eclipse, the first contact was well observed, but at the same time a bank of clouds was seen in the west that started our fears. The clouds soon covered the sun, and it seemed, more and more, as if the whole period of totality would be lost. However, a few minutes before the 113 seconds of totality began, to the joyful surprise of the Carleton party, the dense cloud broke away very suddenly, and the total phase was seen in a fairly good sky. We then remembered the kind words said to us before by the Chico friends: "We have been praying for you to-day." Others may, but we do not doubt the help of prayer in the success we enjoyed. This is one of the ways in which the Almighty works.

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*John Tatlock, Jr.*, care of North River Safe Deposit Co., 187 Greenwich Street, New York, U. S. A., requests that those astronomers who secured observations of the occultations of $\alpha$ Tauri by the moon between the dates of Sept. 10, 1884, and March 18, 1888, inclusive, will kindly send to him copies of the records of such observations together with full particulars essential to the reduction thereof.

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*Reflectors vs. Refractors.* An interested young observer has raised the question of the comparative merit in defining power between a reflecting and a refracting telescope. We

give below a portion of his letter for the help it may secure him from others in similar work. "I have a reflector of 9½ inches aperture and 6 feet 9-inch focal length, which I have been using for the past year . . . As test objects, I have observed $\gamma^2$ Andromedæ in steady air, and it was distinctly divided, so that a friend and myself each made independent drawings which corresponded with the one sent me by Professor C. A. Young of Princeton. The small star 5½ min. following Procyon was easily divided. The globular cluster in Hercules (M. 13) was resolved beautifully, looking exactly like the drawing in Chambers' astronomy. . . . .

"If any of your numerous readers who have refractors of 9½-inch aperture and of the best make, will kindly send me some test object either on the moon, planets, or some close double, I will try and prove how close the comparison can be made between the two instruments.

"Hoping I have not trespassed too long on your valuable time, I am, A. B. DEPUY.

216 North Sixth Street, Camden, N. J.

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*Mr. Stark's Observatory.* We have only recently learned of Mr. H. P. Stark's private Observatory at Syracuse, N. Y. His telescope has a Spencer objective of $5\frac{5}{16}$ inches aperture, and equatorial mounting. His observatory is provided with a revolving dome twelve feet in diameter, and is conveniently and favorably located for observation.

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*The Iowa College Observatory* at Grinnell, Ia., is soon to have, if not already in possession, one of the Fauth transit instruments of 3 inches clear aperture with modern improvements. Professor S. J. Buck, who is now in charge of the new Observatory, has been working industriously to obtain a good working outfit and he has been very successful according to late advices. He has secured a Fauth chronograph, has recently finished a new brick transit house and has a sidereal clock in place and running. His mean time clock has already been ordered. Both are by the Seth Thomas Clock Company. From what he says we know Professor Buck is very happy in the prospect of using these fine instruments. We hope he will use the grand illustrations of practical and observational astronomy to enforce spiritual truth

that, as a minister of the Gospel, he loves to proclaim on Sunday. No field of science is so full of fresh and unused material as this.

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*The Leander McCormick Observatory.* A very readable article in the *Scientific American* (Jan. 26), from the pen of H. C. Hovey, gives a full account of the Leander McCormick Observatory, at the University of Virginia, Professor Ormond Stone Director. A fine engraving of the Observatory building accompanies the article. We also notice the following paragraphs which give items of history of the Observatory new to us:

"The McCormick family, inventors of the well known reaper, originated in Rockbridge county, Va. Leander, the youngest of the three brothers bearing that name, residing in the city of Chicago, desired to do something to prove his affection for his native state; therefore contracted with Alvan Clark & Sons, of Cambridge, Mass., for a mate to the splendid telescope they were then making for the National Observatory at Washington, D. C., with certain noted improvements, and offered, on specified conditions, to present it to the Washington and Lee University, at Lexington, in the county where he had been born. As those conditions were not met, he next offered it to the University of Virginia, through Col. Venable, the Professor of Mathematics in the latter institution, who immediately took steps toward raising the necessary endowment. In answer to an appeal to the State Legislature, that body passed resolutions recognizing the generosity of the donor and the importance of securing such a telescope, but did not deem it wise, in the condition of the state finances at that time (1878), to make the appropriation asked for.

"Gen. Johnston, now of the South Carolina Military Academy, at Charleston, then visited the alumni of the University, pursuant to an appeal made by the executive committee, and raised over $50,000 to secure the $3,000 salary of the astronomer in charge. Mr. William H. Vanderbilt of New York added $25,000 as the beginning of a working fund. The University gave the ample grounds on the summit of Mount Jefferson, and also built the astronomer's residence, at a cost of $8,000. Mr. McCormick then gave the tele-

scope, costing $46,000, and the building in which it is housed, costing $18,000; thus making a sum total, including the smaller buildings, etc., of $150,000. The Observatory was completed in 1884."

*Stonyhurst College Observatory.* The Rev. S. J. Perry, in charge of Stonyhurst Observatory, favors us with a copy of his results of meteorological and magnetical observations for the year 1887. In this report, we notice that solar drawings of spots and faculæ were made on 259 different days, and that complete measurements of the height of the chromosphere were secured on 123 occasions. The inclination of the filaments of the chromosphere and of the lesser prominences was also observed when the definition was good enough for such work.

*Death of Robert D. Schimpff.* During our absence on the Pacific Coast a telegram was received at the office, announcing the death of Robert D. Schimpff, Scranton, Pa., after a brief illness of typhoid fever. This sad event was so sudden that his physician was not apprehensive of danger until the day preceding the last. With like surprise did this unwelcome news come to us. Though we had no personal acquaintance with Mr. Schimpff, yet we had corresponded with him, invited and heartily welcomed his scientific articles for publication, and in such ways had learned to esteem him very highly for his scholarly and his manly qualities. Though a comparatively young man we do not wonder that he had so won the choice regard of the best in his home city, and that he had been called of their partiality to occupy places of trust and responsibility. It was only a fitting testimonial to modest merit that always rules, to some extent, in the consciences of men. Mr. Schimpff was an eager student of science. He was greatly interested in astronomy and physics, especially spectrum analysis. His observations with instruments were sought by the best periodicals on astronomy, and his skill in celestial photography has already been shown to our readers by engravings in this magazine which were copies of fine photographs wholly his own work. Professor Young spoke well of him when he said to a friend a little while ago: "He was so bright and quick in

his thinking, so interested in everything new in science, and so enthusiastic in regard to its progress and prosecution that an interview with him was an inspiration."

We do not wonder, I say, that those who knew him best should vie with one another to do his name and memory honor, as he steps off the shores of time to those of his other Home. The account of the memorial services which we had the pleasure of reading was indeed the fitting close of a life of beauty and power.

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*Captain R. S. Floyd* has recently added a fine 5-inch telescope by Alvan Clark & Sons to the outfit of his private Observatory at Kono Tayee, Clear Lake. By reversing the crown glass lens, which is fitted into a separate cell, the objective is converted into a photographic combination, the lenses being then separated by a distance of 1.7 inches and the focal length being 65.6 inches. With the visual arrangement the lenses are nearly in contact, and the focal length is 77 inches.

The telescope is mounted equatorially on a long polar axis, according to the English plan. It has an enlarging apparatus, with instantaneous shutter for solar photography. Two negatives of the corona were obtained by Captain Floyd during the total eclipse of Jan. 1st, the instrument having been roughly mounted for the purpose in the open air.

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*Astronomische Mittheilungen.* We deem ourselves fortunate to obtain Dr. Rudolf Wolf's publication, *Astronomische Mittheilungen*, for the last eleven years, for place in our astronomical library. Dr. Wolf is professor of astronomy in Zeurich, Switzerland.

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*Mr. Tebbutt's Observatory.* A neat pamphlet of 74 pages is before us, which gives the history and description of Mr. Tebbut's Observatory, Windsor, New South Wales.

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*Harvard College Observatory.* The 43rd annual report of Professor E. C. Pickering of the Harvard College Observatory contains points of interest. The income of the Observatory has increased so much during the last three years that the as-

tronomical work of the Observatory is materially advanced and enlarged. The Observatory can now invite coöperation of other smaller observatories, in certain lines of work. It is undertaking mountain astronomical observations at various points, at the present time, and it has assumed the control of the meteorological work of the New England society. This is in addition to the regular work going on at Cambridge which is a continuation of that formerly reported. We notice with pleasure the work that is being done at this Observatory in the new field of variable stars. The report says:

Messrs. Parkhurst, Eadie, and Hagen have continued their co-operation with this Observatory in collecting fresh material for the study of the variable stars. Mr. Parkhurst's preliminary series of observations on the variations of the asteroids, mentioned last year, has been published as No. III. in the collection of separate memoirs which will constitute Volume XVIII. of the Annals of the Observatory. Communications which will aid in the construction of the Index to Observations of Variable Stars, undertaken last year, have been received from the following foreign observers: Mr. T. W. Backhouse, of Sunderland, England; Messrs. Joseph Baxendell and Joseph Baxendell, Jr., of Southport, England; Rev. T. E. Espin, of Wolsingham, England; Mr. J. E. Gore, of Ballysodare, Ireland; Mr. George Knott, of Cuckfield, England; Major E. E. Markwick, of Queenstown, Ireland; Mr. C. E. Peek, of Lyme Regis, England; Mr. J. Plassman, of Warendorf, Germany; Professor Safarik, of Prague, Austria. Two large series of earlier unpublished observations have also been obtained, and it has been thought best to delay the publication of the Index above mentioned until these series could be received and utilized. The first series consists of observations by the late Professor E. Heis, of Munster, Germany. The records of these observations were transmitted by the family of Professor Heis to the Rev. J. G. Hagen, S. J., who has kindly communicated them to this Observatory. The second series contains the observations of the late Dr. J. F. J. Schmidt, preserved in manuscript at Potsdam. Professor H. C. Vogel, Director of the Potsdam Observatory, has kindly directed the preparation of a copy of these observations for use in the proposed Index. The printing of the Index has been begun, and it is hoped that the work may soon be distributed.

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*Stellar Parallax.* In the *Monthly Notices* of the R. A. S. for Nov. 1888, Professor Pritchard gives some results of the work done at the University Observatory, Oxford, during the past year, in determining the parallax of stars by means of photography. The work has been confined to stars of the second magnitude, as the parallaxes of those of the first magnitude have already been derived by various astronomers and very recently have been the subject of investiga-

tion by Dr. Elkin, with the Yale College heliometer. The following table gives the final results obtained for μ *Cassiopeiæ* and *Polaris* and provisional results for α, β and γ *Cassiopeiæ*. The necessary photographic plates have been secured for completing the investigation of the parallaxes of α *Cephei*, γ and ε *Cygni*, γ *Coronæ*, α and β *Andromedæ*. Professor Pritchard thinks that to determine the parallaxes of twelve stars annually by this method is about the limit of work to be anticipated from the exertions of a single observer with a single instrument in the climate of England.

*Table Showing the Parallaxes of Stars Recently Determined at the University Observatory, Oxford, England,*

| Stars of Comparison. | Magnitude of Comparison Stars. | Differential Parallax. | Probable error of Result. | Parallax from other Authorities. | |
|---|---|---|---|---|---|
| | | μ CASSIOPEIÆ. | | | |
| ° | | ″ | ″ | | ″ |
| D M 54 No. 225 | 7.7 | 0.0211 | 0.023 | Bessel | −0.120 |
| " 54 " 217 | 9.2 | 0.0501 | 0.027 | Struve | +0.342 |
| | | POLARIS. | | | |
| D M 88 No. 4 | 6.7 | 0.0429 | 0.015 | Lindenau | 0.144 |
| " 88 " 2 | 8.3 | 0.0758 | 0.014 | Struve & Peters | 0.172 |
| " 88 " 9 | 8.4 | 0.0623 | 0.016 | C. A. F. Peters | 0.067 |
| " 88 " 10 | 9.6 | 0.0992 | 0.013 | | |
| | | α CASSIOPEIÆ. | | | |
| D M 55 No. 142 | 8.7 | 0.0748 | 0.024 | | |
| " 55 " 128 | 9.5 | 0.0678 | 0.055 | | |
| | | β CASSIOPEIÆ. | | | |
| D M 58 No. 8 | 8.6 | 0.1759 | 0.047 | | |
| " 58 " 2700 | 8.8 | 0.1484 | 0.056 | | |
| | | γ CASSIOPEIÆ. | | | |
| D M 59 No. 137 | 8.8 | −0.014 | 0.047 | | |
| " 59 " 150 | 8.9 | +0.007 | 0.042 | | |

Speaking of the differences between the results obtained by different observers, Professor Pritchard says: "Guided by the suggestions of recent experience, I now think that such differences of 'parallax' might very reasonably have been anticipated, and may properly be accepted as matters of fact, without in any degree impugning the accuracy of the observations. For in the process of this work on parallax, and also from the general history of such inquiries, it has been made abundantly evident that no necessary connection exists between the brightness of a star and its position in space or distance from the sun. Nevertheless it is this very difference of brightness mainly which guides us in the selection of comparison stars. The 'Parallax' is, in fact,

and is becoming more and more generally recognized to be a differential quantity, fainter stars being in very many instances much nearer to us than others possessing incomparably greater brightness." He calls attention, however, to the fact that the parallax of *Polaris*, as determined with reference to the four comparison stars, varies somewhat in proportion to the difference in brightness of Polaris and these stars.

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*U. S. Naval Observatory.* By kindness of Lieut. Winterhatler we have received a copy of the report of the superintendent of the U. S. Naval Observatory for the year 1888. From it we learn that the contract for the erection of nine buildings comprising the new Observatory has been awarded to Messrs. P. H. McLaughlin & Co., Washington, D. C., and that work on the same has begun. The amount already appropriated by Congress is not sufficient to complete the new Observatory, but doubtless the deficiency will be made up in time. During the removal from the old to the new Observatory the use of Washburn Observatory has been tendered by the regents of the University of Wisconsin for such aid in astronomical work as might be desired on the part of the Naval Observatory. Coördination work between the two observatories has been invited and cordially accepted. Professor N. Hall is consulting director of Washburn Observatory, and Professor S. J. Brown is on duty there also.

We were also interested in the letter of Lieut. Winterhatler to the superintendent of the Naval Observatory concerning his European visit to observatories and scientific institutions under orders from the Department. His full report will be looked for with interest after publication.

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*Visit at the Lick Observatory.* One of the treats of our late western trip was the half day spent with Professors Holden and Schæberle at the Lick Observatory. On the morning of Jan. 3 we left San José by stage, to go to the top of Mt. Hamilton, a distance by road of twenty-six miles; and in a straight line only thirteen miles. A zigzag course for this fine driveway was chosen that an easy grade might be secured for the entire distance. The maximum in any part of it, we believe, does not exceed 343 feet to the

mile. It was a beautiful day, and the drive for six hours in the midst of such a variety of scenery, was most delightful.

At two o'clock in the afternoon our party had the pleasure of meeting Professor Holden in his famous Observatory and mountain home, and we were welcomed right royally. We looked at instruments from the mammoth equatorial down to the end of the list (and it was a long and interesting one), we saw the library, the rooms and work of individual astronomers and something of the plans for future work.

The single regret was, that the evening should be cloudy so as to prevent a use of the 36-inch equatorial on some celestial objects to understand its marvelous power to penetrate the star depths, or to show details of the planets' surfaces.

*Sir George B. Airy.* It is an interesting and very impressive fact that the distinguished Sir George B. Airy at his present advanced age (88 years old) is still working on one of the most difficult problems known to astronomy, "The numerical lunar theory," as he titles it. He recently says that through failing strength and advanced years he can scarcely hope to complete the work he has undertaken, but that he still keeps his attention to the general subject, and that he believes the method he has chosen, if properly used, would have led to a comparatively easy process but for a serious mistake previously pointed out.

### Books Received.

Star Atlas containing Maps of all the Stars from 1 to 6.5 magnitude between the North Pole and 34° South Declination, and of all Nebulæ and Star Clusters in the same region which are visible in telescopes of moderate powers. Explanatory text by Dr Herman J. Klein. Translated and adapted to English readers by Edmund McClure, M. A., M. R. I. A. Eighteen maps. London: Published by the Society for Promoting Christian Knowledge. Also, New York: Messrs. E. & J. B. Young & Co.

An Elementary Treatise on Analytic Geometry, embracing Plane Geometry and an introduction to Geometry of three dimensions. By Edward L. Bowser, LL. D., Professor of Mathematics and Engineering in Rutgers College. New York: Published by D. Van Nostrand, 23 Murray Street, 1888, pp. 287.

Tornadoes, What They Are, and How to Escape Them. By John P. Finley, Lieutenant Signal Corps, U. S. Army. Washington: J. H. Soule, Publisher, 1888. Price 25 cents, pp. 90.

Publishers and others sending books to the MESSENGER for notice will confer a favor by stating, with each book, the retail price, so that the same may be incorporated in the notice of the book for publication.